PATENT ABSTRACTS OF JAPAN

(11)Publication number : **05-161211**
(43)Date of publication of application : **25.06.1993**

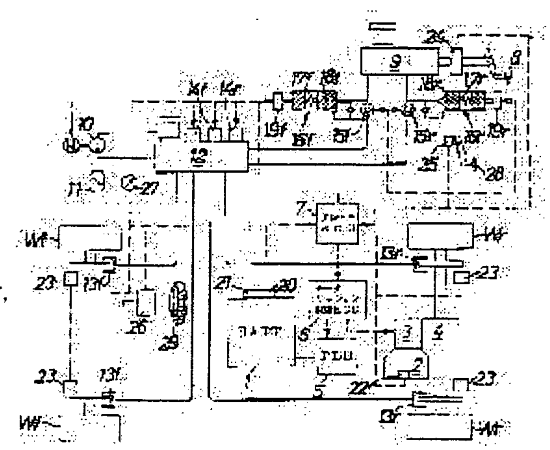
(51)Int.Cl. **B60L 7/24**
B60T 8/26

(21)Application number : **03-322082**
(22)Date of filing : **05.12.1991**

(71)Applicant : **HONDA MOTOR CO LTD**
(72)Inventor : **AOKI YASUSHI**
ASANUMA SHINKICHI
ONO ATSUO
OBA TAKESHI

(54) BRAKE SYSTEM FOR MOTOR VEHICLE

(57)Abstract:
PURPOSE: To provide a brake system for vehicle employing combined regenerative brake and hydraulic brake in which energy recovery efficiency is enhanced as high as possible through regenerative brake.
CONSTITUTION: ON/OFF valves 15f, 15r and differential pressure valves 16f, 16r detouring the ON/OFF valves 15f, 15r are arranged in an oil passage coupling between a master cylinder 9 and brake cylinders 13f, 13r for front and rear wheels Wf, Wr. When a battery 1 is charged with power generated from a motor 2 through regenerative brake of the rear wheel Wr, the ON/OFF valves 15f, 15r are closed and brake oil pressure to be transmitted to the brake cylinders 13f, 13r is regulated by means of the differential pressure valves 16f, 16r thus suspending hydraulic brake and applying regenerative brake preferentially on the front and rear wheels Wf, Wr. Opening pressure of the differential pressure valves 16f, 16r can be regulated by varying the loads to be set for springs 17f, 17r.



LEGAL STATUS

[Date of request for examination] 30.10.1997

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number] 3160722

[Date of registration] 23.02.2001

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] The coupled driving wheel in which oil pressure braking by operation of a brakes operation child (8) is possible (Wf) While connecting with the motor (2) made into an energy source and driving a battery (1), it is the driving wheel (Wr) in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child (8). Between the master cylinder (9) which is the damping device of the electric vehicles equipped with the above, is connected to the aforementioned brakes operation child (8), and generates braking oil pressure, and the brake cylinder (13f) of a coupled driving wheel (Wf) When the differential pressure bulb (16f) which prevents transfer of the braking oil pressure to the aforementioned brake cylinder (13f) is made to intervene and regenerative braking of a driving wheel (Wr) is performed until the aforementioned braking oil pressure rises exceeding place constant pressure, it is characterized by regulating oil pressure braking of a coupled driving wheel (Wf).

[Claim 2] The coupled driving wheel in which oil pressure braking by operation of a brakes operation child (8) is possible (Wf) While connecting with the motor (2) made into an energy source and driving a battery (1), it is the driving wheel (Wr) in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child (8). Between the master cylinder (9) which is the damping device of the electric vehicles equipped with the above, is connected to the aforementioned brakes operation child (8), and generates braking oil pressure, and the brake cylinder (13r) of a driving wheel (Wr) When the differential pressure bulb (16r) which prevents transfer of the braking oil pressure to the aforementioned brake cylinder (13r) is made to intervene and regenerative braking of a driving wheel (Wr) is performed until the aforementioned braking oil pressure rises exceeding place constant pressure, it is characterized by regulating oil pressure braking of this driving wheel (Wr).

[Claim 3] The damping device of electric vehicles according to claim 1 or 2 which the aforementioned differential pressure bulb (16f, 16r) is equipped with the spring (17f, 17r) which determines the aforementioned place constant pressure, and is characterized by the ability to adjust the set load of the spring (17f, 17r).

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the damping device of the electric vehicles equipped with the driving wheel in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child while connecting with the motor which makes an energy source the coupled driving wheel in which oil pressure braking is possible, and a battery by operation of a brakes operation child and driving it.
[0002]
[Description of the Prior Art] The damping force which is equivalent to the engine brake of the vehicles equipped with the internal combustion engine in the vehicles it runs by the electric motor which makes a battery an energy source is conventionally demonstrated with regenerative braking of the aforementioned motor, and the thing aiming at extension of rolling-stock-run possible distance is used by charging a battery with the power obtained as a result.
[0003] Moreover, in the vehicles equipped with the driving wheel which can be braked by oil pressure and regeneration, and the coupled driving wheel which can be braked with oil pressure, what will start oil pressure braking of a driving wheel if it carries out by carrying out the concurrency of regenerative braking of a driving wheel and the oil pressure braking of a coupled driving wheel at the time of initial braking and the aforementioned regenerative-braking force reaches limiting value is well-known by JP,49-28933,B.
[0004]
[Problem(s) to be Solved by the Invention] By the way, since a part of aforementioned kinetic energy will be consumed by oil pressure braking of a coupled driving wheel from the time of initial braking with the largest kinetic energy of vehicles, the thing given [above-mentioned] in an official report was impossible for fully being unable to demonstrate the energy-recovery effect by regenerative braking, and extending greatly the distance per 1 charge of a battery which can be run.
[0005] It aims at this invention having been made in view of the above-mentioned situation, raising the energy-recovery efficiency by regenerative braking as much as possible in the damping device of the vehicles which use together regenerative braking and oil pressure braking, and extending the distance per 1 charge of a battery which can be run.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the coupled driving wheel which this invention can oil pressure brake by operation of a brakes operation child, In the damping device of the electric vehicles equipped with the driving wheel in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child while connecting with the motor made into an energy source and driving a battery Between the master cylinder which is connected to the aforementioned brakes operation child and generates braking oil pressure, and the brake cylinder of a coupled driving wheel When the differential pressure bulb which prevents transfer of the braking oil pressure to the aforementioned brake cylinder is made to intervene and regenerative braking of a driving wheel is performed until the aforementioned braking oil pressure rises exceeding place constant pressure,

it is characterized [1st] by regulating oil pressure braking of a coupled driving wheel.
[0007] Moreover, the coupled driving wheel which this invention can oil pressure brake by operation of a brakes operation child, In the damping device of the electric vehicles equipped with the driving wheel in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child while connecting with the motor made into an energy source and driving a battery Between the master cylinder which is connected to the aforementioned brakes operation child and generates braking oil pressure, and the brake cylinder of a driving wheel When the differential pressure bulb which prevents transfer of the braking oil pressure to the aforementioned brake cylinder is made to intervene and regenerative braking of a driving wheel is performed until the aforementioned braking oil pressure rises exceeding place constant pressure, it is characterized [2nd] by regulating oil pressure braking of this driving wheel.
[0008] Moreover, in addition to the 1st of the above-mentioned [this invention], or the 2nd feature, the aforementioned differential pressure bulb is characterized [3rd] by the ability of the set load of the spring to equip with the spring which determines the aforementioned place constant pressure, and adjust it.
[0009] Moreover, it is characterized [4th] by this invention preparing the aforementioned differential pressure bulb in the oilway which the ON/OFF bulb which closes the valve at the time of regenerative braking, and opens at the time of oil pressure braking is made to intervene between the aforementioned master cylinder and a brake cylinder in addition to the above-mentioned 1st or the 2nd feature, and bypasses this ON/OFF bulb.
[0010]
[Example] Hereafter, the example of this invention is explained based on a drawing.
[0011] It is the flow chart, graph, and timing diagram the whole electric vehicles block diagram in which drawing 1 - drawing 23 show one example of this invention, and which drawing 1 equipped with the damping device, and drawing 2 explain the block diagram of a control system, and, as for outline explanatory drawing in braking mode, drawing 4 - drawing 23 , drawing 3 explains an operation to be.
[0012] As shown in drawing 1 , these electric vehicles are the four-flower vehicles equipped with the rear wheel Wr of the couple as the front wheel Wf and driving wheel of a couple as a coupled driving wheel, and a rear wheel Wr is connected to the electric motor 2 which makes a battery 1 an energy source through the transmission 3 of four steps of advance, and a differential gear 4. While PDU (power drive unit)5 is infixed between a battery 1 and a motor 2 and controlling the drive of the motor 2 by the battery 1, charge of the battery 1 by the power which a motor 2 generates in connection with regenerative braking is controlled. The above PDU 5 and transmission 3 are connected to the motor missions control (electronic control unit) ECU 6, and this motor missions control ECU 6 is connected to a brake (electronic control unit) ECU 7.
[0013] The master cylinder 9 which operates by the brake pedal 8 is connected to brake cylinder 13f of each front wheel Wf, and brake cylinder 13r of each rear wheel Wr through the modulator 12 connected to the accumulator 11 accumulated with a hydraulic pump 10. A modulator 12 decompresses the brake oil pressure transmitted to those brake cylinders 13f and 13r, when it has ABS control bulb of one channel 14r ABS (anti-lock brake system) control bulb of two channels 14f for front wheels, and for rear wheels and a lock inclination arises in a front wheel Wf and a rear wheel Wr.
[0014] The oil-pressure-control bulb which consists of ON/OFF bulb 15r and differential pressure bulb 16r by which the oil-pressure-control bulb which consists of ON/OFF bulb 15f and differential pressure bulb 16f which controls the brake oil pressure transmitted to brake cylinder 13f of a front wheel Wf controls the brake oil pressure transmitted to brake cylinder 13r of a rear wheel Wr again is infixed in the oilway which connects a master cylinder 9 and a modulator 12, respectively.
[0015] ON/OFF bulb 15f for front wheels, it is the normally open opening-and-closing valve driven by the solenoid, and the free passage between a master cylinder 9 and a modulator 12 is intercepted if needed. Differential pressure bulb 16f for front wheels, it is prepared in the bypass oilway which bypasses the aforementioned ON/OFF bulb 15f, and has 18f of valve elements

energized in the valve-closing direction by spring 17f, and linear solenoid 19f which adjusts an aforementioned spring 17f set load. ON/OFF bulb 15r for rear wheels and differential pressure bulb 16r are equipped with the same structure as it for front wheels. In addition, to the aforementioned bypass oilway, transfer of the oil pressure from a master cylinder 9 to a modulator 12 is regulated, and the unidirectional valve which permits transfer of the oil pressure from a modulator 12 to a master cylinder 9 is infixed.

[0016] So that clearly, when drawing 2 is referred to collectively with the aforementioned brake ECU 7 Battery remaining capacity 20 [a total of] and the battery temperature sensor 21 which were prepared in the battery 1, The motor rotational frequency sensor 22 which detects the rotational frequency of a motor 2, and the wheel speed sensor 23 formed in the front wheel Wf and the rear wheel Wr, The brake-pedal treading strength sensor 24 formed in the aforementioned brake pedal 8, While the accelerator opening sensor 25 formed in the accelerator pedal 28, the steering sensor 26 formed in the steering wheel 29, and the accumulator ** sensor 27 formed in the aforementioned accumulator 12 are connected The aforementioned hydraulic pump 10 controlled based on those output signals, the oil-pressure-control bulb which consists of the aforementioned ON/OFF bulbs 15f and 15r and the differential pressure bulbs 16f and 16r, and the aforementioned ABS control bulbs 14f and 14r are connected.

[0017] Moreover, the above PDU 5 and the aforementioned transmission 3 which control a battery 1 and a motor 2 are connected to the motor missions control ECU 6 which operates in response to the regenerative-braking instructions from the aforementioned brake ECU 7, and missions shift instructions.

[0018] Next, the outline in each braking mode is explained based on drawing 3 .

[0019] There are three kinds of braking modes of a front wheel Wf and a rear wheel Wr in the vehicles equipped with this damping device, [the mode 3], [the mode 2], and [the mode 1], and while it is chosen by initial judging the any they are and braking by the predetermined mode is performed, a change in the mode is made by change of operational status during braking.

** [Mode 3] This mode is chosen in the usual operational status. That is, the regenerative-braking system is functioning normally, and it is chosen, when it is not at the slam-on-the-brake time, either and is not among a steering, either. [The mode 3] is the mode in which oil pressure brakes a front wheel Wf and oil pressure and regeneration brake a rear wheel Wr, if a brake pedal 8 is stepped on, probably, regenerative braking only of the rear wheel Wr will be carried out, and oil pressure braking of a front wheel Wf will not be performed. And if the damping force of a rear wheel Wr reaches a break point P, oil pressure braking of a front wheel Wf will be started from the moment. If the damping force of a rear wheel Wr exceeds the regeneration limitation determined from the various conditions of a battery 1 or a motor 2, a rear wheel Wr will be braked by combined use of regeneration and oil pressure. And if damping force reaches a break point Q, the damping force of a rear wheel Wr can weaken by operation of the proportionality reducing valve of the common knowledge prepared in the interior of the aforementioned modulator 12, and a braking-force-distribution property as shown by polygonal-line OPQR after all is given. This braking-force-distribution property OPQR is deflected so that the braking force distribution of **** [property / ideal distribution / which is shown with a dashed line] Wr, i.e., a rear wheel, may exceed an ideal distribution property, it charges a battery 1 by this, using regenerative braking of a rear wheel Wr as much as possible, and is aiming at extension of the distance per 1 charge which can be run.

** [Mode 2] The regenerative-braking system is functioning normally and this mode is not at the slam-on-the-brake time, however when it is among a steering, it is chosen. It is the mode in which this the [mode 2] brakes a front wheel Wf with oil pressure, and brakes a rear wheel Wr by oil pressure and regeneration like the above-mentioned [mode 3]. However, if a brake pedal 8 is stepped on, oil pressure braking of a front wheel Wf will be performed in concurrency with regenerative braking of a rear wheel Wr, and if the damping force of a rear wheel Wr exceeds a regeneration limitation in the meantime, a rear wheel Wr will be braked by combined use of regeneration and oil pressure. And the polygonal line OQR which the damping force of a rear wheel Wr can weaken with a proportionality reducing valve if damping force reaches a break point R, and, as a result, shows the braking-force-distribution property in [the mode 2] becomes

what put specific gravity on the damping force of a front wheel Wf from the ideal distribution property shown with a dashed line. Thus, by choosing [the mode 2] into a steering and braking a front wheel Wf and a rear wheel Wr simultaneously from the time of initial braking, the fall of driving stability is avoidable.
** [Mode 1] This mode is chosen at the time of a slam on the brake when the regenerative-braking system is functioning normally, when a regenerative-braking system does not function normally. In this the [mode 1], regenerative braking of a rear wheel Wr is not performed, but a front wheel Wf and a rear wheel Wr are braked by each with oil pressure. Thus, by performing only oil pressure braking, without performing regenerative braking of a rear wheel Wr, while transmitting rotation of a rear wheel Wr to a motor 2 through a differential gear 4 or transmission 3, it becomes possible to raise the responsibility of damping force to responsibility compared with regenerative braking which some delay produces. **(ing), the braking-force-distribution property shown by the polygonal line OQR becomes what put specific gravity on the damping force of a front wheel Wf from the ideal distribution property shown with a dashed line as well as the above-mentioned [mode 2]. Improvement in responsibility of braking is achieved by choosing [the mode 1] into a slam on the brake as mentioned above.
[0020] At the time of the slam on the brake under braking by the above-mentioned [mode 3], a change in [the mode 1] from [the mode 3] is made. On the other hand, when steering operation is performed during braking by [the mode 3], or when the lock inclination of the wheel by the low mu way is detected When a change in [the mode 2] from [the mode 3] is made and the lock inclination of the still stronger wheel by the low mu way is detected during braking by [the mode 2], a change in [the mode 1] from [the mode 2] is made. Thus, the fall of driving stability is avoidable by choosing [the mode 2] or [the mode 1] by the road surface mu. A change in [the mode 2] or [the mode 1] from the above [the mode 3] is made along with a line by which the sum of the damping force of the ** system power line Wf, i.e., a front wheel, and the damping force of a rear wheel Wr is kept constant, and it is avoided that the total damping force of order both wheels Wf and Wr changes suddenly by this.
[0021] Next, an operation of the damping device equipped with the above-mentioned composition is explained based on the flow chart of a main routine shown in drawing 4 .
[0022] First, in Step S100, various programs and data are memorized by a brake ECU 7 and the storage of the motor missions control ECU 6, and it changes initial setting into the state where a damping device can operate. At continuing Step S200, the output signal of the aforementioned battery remaining capacity 20 [a total of], the battery temperature sensor 21, the motor rotational frequency sensor 22, the wheel speed sensor 23, the brake-pedal treading strength sensor 24, the accelerator opening sensor 25, the steering sensor 26, and the accumulator ** sensor 27 is read into a brake ECU 7 (refer to drawing 2).
[0023] At Step S300, the limiting value of the regenerative-braking force which can be demonstrated calculates based on the output signal of the various aforementioned sensors between each **. This regenerative-braking force limitation is determined according to the state of a battery 1, or the state of a motor 2, and the detail carries out a back shell detailed explanation based on the sub routine of Step S300.
[0024] At Step S400, the regenerative-braking force of engine brake calculates. Although engine brake will operate by the vehicles which make an internal combustion engine the source for a run of power if the treading strength of an accelerator pedal is canceled, the same operation feeling as the usual vehicles with an internal combustion engine is given like this example by the vehicles which make a motor 2 the source for a run of power by making the damping force equivalent to the aforementioned engine brake act on a rear wheel Wr with regenerative braking. That is, if the treading strength of an accelerator pedal 28 can weaken, the damping force of engine brake will calculate based on the accelerator opening detected by the accelerator opening sensor 25, the motor rotational frequency detected by the motor rotational frequency sensor 22, and the wheel speed detected by the wheel speed sensor 23, and regenerative braking of the rear wheel Wr connected to the motor 2 to obtain the damping force will be carried out. And charge of a battery 1 is presented with the power which the motor 2 generated with regenerative braking.

[0025] At Step S500, the distribution ratio of the regenerative-braking force and oil pressure damping force calculates. That is, while the above [the mode 3], [the mode 2], and [the mode 1] are chosen based on the state of the braking operation and steering operation by the driver, or coefficient of friction of a road surface, the mode change in [the mode 2] or [the mode 1] from [the mode 3] is determined. And in each mode, the size of the oil pressure damping force of a front wheel Wf and the size of the regenerative-braking force of a rear wheel Wr and oil pressure damping force calculate. The concrete content of Step S500 carries out a back shell detailed explanation based on the sub routine.
[0026] At Step S600, the shift position which can demonstrate the regenerative-braking force to the maximum extent calculates, and transmission 3 is automatically operated towards the aforementioned shift position. The concrete content of Step S600 carries out a back shell detailed explanation based on the sub routine.
[0027] The ON/OFF bulbs 15f and 15r and the differential pressure bulbs 16f and 16r of drawing 1 are actually controlled by Step S700 that the regenerative-braking force and oil pressure damping force should be distributed by the predetermined ratio. It ** and charge of a battery 1 is presented with the power which the motor 2 generated with regenerative braking of a rear wheel Wr. The concrete content of Step S700 carries out a back shell detailed explanation based on the sub routine.
[0028] At Step S800, antilock control is performed that a superfluous slip of a front wheel Wf or a rear wheel Wr should be prevented. That is, detection of that the wheel went into the lock state by the output signal of the wheel speed sensor 23 controls the ABS control bulbs 14f and 14r of drawing 1 . The modulator 12 infixed between a master cylinder 9, brake cylinder 13f, and 13r operates by this, the brake oil pressure transmitted to the brake cylinders 13f and 13r of the wheel in the aforementioned lock inclination is decompressed, and the lock of a wheel is prevented.
[0029] At Step S900, a failsafe when failure arises to a regenerative-braking system is planned. That is, as shown in the flow of drawing 3 , when failure arises to a regenerative-braking system, the normally open ON/OFF bulbs 15f and 15r are held in a valve-opening position, and a master cylinder 9 and a modulator 12 are directly open for free passage. Consequently, [the mode 1] is chosen unconditionally and a front wheel Wf and a rear wheel Wr are braked by oil pressure like the usual oil pressure braking system.
[0030] Next, the concrete content of Step S300 (regenerative-braking force limiting value operation) of the flow chart of above-mentioned drawing 4 is explained based on drawing 5 - drawing 8 .
[0031] Limiting value TLMB of the regenerative-braking force according to the state of a battery 1 at Step S301 first as shown in the regenerative-braking force limiting value operation routine of drawing 5 Limiting value TLMN of the regenerative-braking force calculate and according to the rotational frequency of a motor 2 at Step S302 further It calculates. The aforementioned limiting value TLMB Limiting value TLMN It is compared by Step S303 and size is limiting value TLMB. Limiting value TLMN Limiting value TLMN of the one smaller when large at Step S304 It is chosen as regenerative-braking force limiting value TLM, and is limiting value TLMB. Limiting value TLMN Limiting value TLMB of the one smaller when it is the following at Step S305 It is chosen as regenerative-braking force limiting value TLM. That is, the regenerative-braking force limiting value TLM at that time is the limiting value TLMB by the state of a battery 1. Limiting value TLMN at the rotational frequency of a motor 2 Any or the smaller one is determined.
[0032] Next, the sub routine of Step S301 (limiting value operation by the battery state) of aforementioned drawing 5 is explained based on drawing 6 .
[0033] ** [detection of that brakes operation was performed by the output signal of the brake-pedal treading strength sensor 24 at Step S311 / start / a count / the regeneration on-timer RBT / at Step S312] Then, based on battery remaining capacity a total of 20 output signals, the depth of discharge (DOD) of a battery 1 calculates at Step S313.
[0034] At continuing Step S314 - Step S318, limiting value TLMB0 is determined based on the size of Above DOD.

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the damping device of the electric vehicles equipped with the driving wheel in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child while connecting with the motor which makes an energy source the coupled driving wheel in which oil pressure braking is possible, and a battery by operation of a brakes operation child and driving it.
[0002]
[Description of the Prior Art] The damping force which is equivalent to the engine brake of the vehicles equipped with the internal combustion engine in the vehicles it runs by the electric motor which makes a battery an energy source is conventionally demonstrated with regenerative braking of the aforementioned motor, and the thing aiming at extension of rolling-stock-run possible distance is used by charging a battery with the power obtained as a result.
[0003] Moreover, in the vehicles equipped with the driving wheel which can be braked by oil pressure and regeneration, and the coupled driving wheel which can be braked with oil pressure, what will start oil pressure braking of a driving wheel if it carries out by carrying out the concurrency of regenerative braking of a driving wheel and the oil pressure braking of a coupled driving wheel at the time of initial braking and the aforementioned regenerative-braking force reaches limiting value is well-known by JP,49-28933,B.
[0004]
[Problem(s) to be Solved by the Invention] By the way, since a part of aforementioned kinetic energy will be consumed by oil pressure braking of a coupled driving wheel from the time of initial braking with the largest kinetic energy of vehicles, the thing given [above-mentioned] in an official report was impossible for fully being unable to demonstrate the energy-recovery effect by regenerative braking, and extending greatly the distance per 1 charge of a battery which can be run.
[0005] It aims at this invention having been made in view of the above-mentioned situation, raising the energy-recovery efficiency by regenerative braking as much as possible in the damping device of the vehicles which use together regenerative braking and oil pressure braking, and extending the distance per 1 charge of a battery which can be run.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the coupled driving wheel which this invention can oil pressure brake by operation of a brakes operation child, In the damping device of the electric vehicles equipped with the driving wheel in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child while connecting with the motor made into an energy source and driving a battery Between the master cylinder which is connected to the aforementioned brakes operation child and generates braking oil pressure, and the brake cylinder of a coupled driving wheel When the differential pressure bulb which prevents transfer of the braking oil pressure to the aforementioned brake cylinder is made to intervene and regenerative braking of a driving wheel is performed until the aforementioned braking oil pressure rises exceeding place constant pressure,

it is characterized [1st] by regulating oil pressure braking of a coupled driving wheel.
[0007] Moreover, the coupled driving wheel which this invention can oil pressure brake by operation of a brakes operation child, In the damping device of the electric vehicles equipped with the driving wheel in which oil pressure braking and regenerative braking are possible by operation of the aforementioned brakes operation child while connecting with the motor made into an energy source and driving a battery Between the master cylinder which is connected to the aforementioned brakes operation child and generates braking oil pressure, and the brake cylinder of a driving wheel When the differential pressure bulb which prevents transfer of the braking oil pressure to the aforementioned brake cylinder is made to intervene and regenerative braking of a driving wheel is performed until the aforementioned braking oil pressure rises exceeding place constant pressure, it is characterized [2nd] by regulating oil pressure braking of this driving wheel.
[0008] Moreover, in addition to the 1st of the above-mentioned [this invention], or the 2nd feature, the aforementioned differential pressure bulb is characterized [3rd] by the ability of the set load of the spring to equip with the spring which determines the aforementioned place constant pressure, and adjust it.
[0009] Moreover, it is characterized [4th] by this invention preparing the aforementioned differential pressure bulb in the oilway which the ON/OFF bulb which closes the valve at the time of regenerative braking, and opens at the time of oil pressure braking is made to intervene between the aforementioned master cylinder and a brake cylinder in addition to the above-mentioned 1st or the 2nd feature, and bypasses this ON/OFF bulb.
[0010]
[Example] Hereafter, the example of this invention is explained based on a drawing.
[0011] It is the flow chart, graph, and timing diagram the whole electric vehicles block diagram in which drawing 1 - drawing 23 show one example of this invention, and which drawing 1 equipped with the damping device, and drawing 2 explain the block diagram of a control system, and, as for outline explanatory drawing in braking mode, drawing 4 - drawing 23 , drawing 3 explains an operation to be.
[0012] As shown in drawing 1 , these electric vehicles are the four-flower vehicles equipped with the rear wheel Wr of the couple as the front wheel Wf and driving wheel of a couple as a coupled driving wheel, and a rear wheel Wr is connected to the electric motor 2 which makes a battery 1 an energy source through the transmission 3 of four steps of advance, and a differential gear 4. While PDU (power drive unit)5 is infixed between a battery 1 and a motor 2 and controlling the drive of the motor 2 by the battery 1, charge of the battery 1 by the power which a motor 2 generates in connection with regenerative braking is controlled. The above PDU 5 and transmission 3 are connected to the motor missions control (electronic control unit) ECU 6, and this motor missions control ECU 6 is connected to a brake (electronic control unit) ECU 7.
[0013] The master cylinder 9 which operates by the brake pedal 8 is connected to brake cylinder 13f of each front wheel Wf, and brake cylinder 13r of each rear wheel Wr through the modulator 12 connected to the accumulator 11 accumulated with a hydraulic pump 10. A modulator 12 decompresses the brake oil pressure transmitted to those brake cylinders 13f and 13r, when it has ABS control bulb of one channel 14r ABS (anti-lock brake system) control bulb of two channels 14f for front wheels, and for rear wheels and a lock inclination arises in a front wheel Wf and a rear wheel Wr.
[0014] The oil-pressure-control bulb which consists of ON/OFF bulb 15r and differential pressure bulb 16r by which the oil-pressure-control bulb which consists of ON/OFF bulb 15f and differential pressure bulb 16f which controls the brake oil pressure transmitted to brake cylinder 13f of a front wheel Wf controls the brake oil pressure transmitted to brake cylinder 13r of a rear wheel Wr again is infixed in the oilway which connects a master cylinder 9 and a modulator 12, respectively.
[0015] ON/OFF bulb 15f for front wheels, it is the normally open opening-and-closing valve driven by the solenoid, and the free passage between a master cylinder 9 and a modulator 12 is intercepted if needed. Differential pressure bulb 16f for front wheels, it is prepared in the bypass oilway which bypasses the aforementioned ON/OFF bulb 15f, and has 18f of valve elements

energized in the valve-closing direction by spring 17f, and linear solenoid 19f which adjusts an aforementioned spring 17f set load. ON/OFF bulb 15r for rear wheels and differential pressure bulb 16r are equipped with the same structure as it for front wheels. In addition, to the aforementioned bypass oilway, transfer of the oil pressure from a master cylinder 9 to a modulator 12 is regulated, and the unidirectional valve which permits transfer of the oil pressure from a modulator 12 to a master cylinder 9 is infixed.

[0016] So that clearly, when drawing 2 is referred to collectively with the aforementioned brake ECU 7 Battery remaining capacity 20 [a total of] and the battery temperature sensor 21 which were prepared in the battery 1, The motor rotational frequency sensor 22 which detects the rotational frequency of a motor 2, and the wheel speed sensor 23 formed in the front wheel Wf and the rear wheel Wr, The brake-pedal treading strength sensor 24 formed in the aforementioned brake pedal 8, While the accelerator opening sensor 25 formed in the accelerator pedal 28, the steering sensor 26 formed in the steering wheel 29, and the accumulator ** sensor 27 formed in the aforementioned accumulator 12 are connected The aforementioned hydraulic pump 10 controlled based on those output signals, the oil-pressure-control bulb which consists of the aforementioned ON/OFF bulbs 15f and 15r and the differential pressure bulbs 16f and 16r, and the aforementioned ABS control bulbs 14f and 14r are connected.

[0017] Moreover, the above PDU 5 and the aforementioned transmission 3 which control a battery 1 and a motor 2 are connected to the motor missions control ECU 6 which operates in response to the regenerative-braking instructions from the aforementioned brake ECU 7, and missions shift instructions.

[0018] Next, the outline in each braking mode is explained based on drawing 3 .

[0019] There are three kinds of braking modes of a front wheel Wf and a rear wheel Wr in the vehicles equipped with this damping device, [the mode 3], [the mode 2], and [the mode 1], and while it is chosen by initial judging the any they are and braking by the predetermined mode is performed, a change in the mode is made by change of operational status during braking.

** [Mode 3] This mode is chosen in the usual operational status. That is, the regenerative-braking system is functioning normally, and it is chosen, when it is not at the slam-on-the-brake time, either and is not among a steering, either. [The mode 3] is the mode in which oil pressure brakes a front wheel Wf and oil pressure and regeneration brake a rear wheel Wr, if a brake pedal 8 is stepped on, probably, regenerative braking only of the rear wheel Wr will be carried out, and oil pressure braking of a front wheel Wf will not be performed. And if the damping force of a rear wheel Wr reaches a break point P, oil pressure braking of a front wheel Wf will be started from the moment. If the damping force of a rear wheel Wr exceeds the regeneration limitation determined from the various conditions of a battery 1 or a motor 2, a rear wheel Wr will be braked by combined use of regeneration and oil pressure. And if damping force reaches a break point Q, the damping force of a rear wheel Wr can weaken by operation of the proportionality reducing valve of the common knowledge prepared in the interior of the aforementioned modulator 12, and a braking-force-distribution property as shown by polygonal-line OPQR after all is given. This braking-force-distribution property OPQR is deflected so that the braking force distribution of **** [property / ideal distribution / which is shown with a dashed line] Wr, i.e., a rear wheel, may exceed an ideal distribution property, it charges a battery 1 by this, using regenerative braking of a rear wheel Wr as much as possible, and is aiming at extension of the distance per 1 charge which can be run.

** [Mode 2] The regenerative-braking system is functioning normally and this mode is not at the slam-on-the-brake time, however when it is among a steering, it is chosen. It is the mode in which this the [mode 2] brakes a front wheel Wf with oil pressure, and brakes a rear wheel Wr by oil pressure and regeneration like the above-mentioned [mode 3]. However, if a brake pedal 8 is stepped on, oil pressure braking of a front wheel Wf will be performed in concurrency with regenerative braking of a rear wheel Wr, and if the damping force of a rear wheel Wr exceeds a regeneration limitation in the meantime, a rear wheel Wr will be braked by combined use of regeneration and oil pressure. And the polygonal line OQR which the damping force of a rear wheel Wr can weaken with a proportionality reducing valve if damping force reaches a break point R, and, as a result, shows the braking-force-distribution property in [the mode 2] becomes

what put specific gravity on the damping force of a front wheel Wf from the ideal distribution property shown with a dashed line. Thus, by choosing [the mode 2] into a steering and braking a front wheel Wf and a rear wheel Wr simultaneously from the time of initial braking, the fall of driving stability is avoidable.

** [Mode 1] This mode is chosen at the time of a slam on the brake when the regenerative-braking system is functioning normally, when a regenerative-braking system does not function normally. In this the [mode 1], regenerative braking of a rear wheel Wr is not performed, but a front wheel Wf and a rear wheel Wr are braked by each with oil pressure. Thus, by performing only oil pressure braking, without performing regenerative braking of a rear wheel Wr, while transmitting rotation of a rear wheel Wr to a motor 2 through a differential gear 4 or transmission 3, it becomes possible to raise the responsibility of damping force to responsibility compared with regenerative braking which some delay produces. **(ing), the braking-force-distribution property shown by the polygonal line OQR becomes what put specific gravity on the damping force of a front wheel Wf from the ideal distribution property shown with a dashed line as well as the above-mentioned [mode 2]. Improvement in responsibility of braking is achieved by choosing [the mode 1] into a slam on the brake as mentioned above.

[0020] At the time of the slam on the brake under braking by the above-mentioned [mode 3], a change in [the mode 1] from [the mode 3] is made. On the other hand, when steering operation is performed during braking by [the mode 3], or when the lock inclination of the wheel by the low mu way is detected When a change in [the mode 2] from [the mode 3] is made and the lock inclination of the still stronger wheel by the low mu way is detected during braking by [the mode 2], a change in [the mode 1] from [the mode 2] is made. Thus, the fall of driving stability is avoidable by choosing [the mode 2] or [the mode 1] by the road surface mu. A change in [the mode 2] or [the mode 1] from the above [the mode 3] is made along with a line by which the sum of the damping force of the ** system power line Wf, i.e., a front wheel, and the damping force of a rear wheel Wr is kept constant, and it is avoided that the total damping force of order both wheels Wf and Wr changes suddenly by this.

[0021] Next, an operation of the damping device equipped with the above-mentioned composition is explained based on the flow chart of a main routine shown in drawing 4 .

[0022] First, in Step S100, various programs and data are memorized by a brake ECU 7 and the storage of the motor missions control ECU 6, and it changes initial setting into the state where a damping device can operate. At continuing Step S200, the output signal of the aforementioned battery remaining capacity 20 [a total of], the battery temperature sensor 21, the motor rotational frequency sensor 22, the wheel speed sensor 23, the brake-pedal treading strength sensor 24, the accelerator opening sensor 25, the steering sensor 26, and the accumulator ** sensor 27 is read into a brake ECU 7 (refer to drawing 2).

[0023] At Step S300, the limiting value of the regenerative-braking force which can be demonstrated calculates based on the output signal of the various aforementioned sensors between each **. This regenerative-braking force limitation is determined according to the state of a battery 1, or the state of a motor 2, and the detail carries out a back shell detailed explanation based on the sub routine of Step S300.

[0024] At Step S400, the regenerative-braking force of engine brake calculates. Although engine brake will operate by the vehicles which make an internal combustion engine the source for a run of power if the treading strength of an accelerator pedal is canceled, the same operation feeling as the usual vehicles with an internal combustion engine is given like this example by the vehicles which make a motor 2 the source for a run of power by making the damping force equivalent to the aforementioned engine brake act on a rear wheel Wr with regenerative braking. That is, if the treading strength of an accelerator pedal 28 can weaken, the damping force of engine brake will calculate based on the accelerator opening detected by the accelerator opening sensor 25, the motor rotational frequency detected by the motor rotational frequency sensor 22, and the wheel speed detected by the wheel speed sensor 23, and regenerative braking of the rear wheel Wr connected to the motor 2 to obtain the damping force will be carried out. And charge of a battery 1 is presented with the power which the motor 2 generated with regenerative braking.

[0025] At Step S500, the distribution ratio of the regenerative-braking force and oil pressure damping force calculates. That is, while the above [the mode 3], [the mode 2], and [the mode 1] are chosen based on the state of the braking operation and steering operation by the driver, or coefficient of friction of a road surface, the mode change in [the mode 2] or [the mode 1] from [the mode 3] is determined. And in each mode, the size of the oil pressure damping force of a front wheel Wf and the size of the regenerative-braking force of a rear wheel Wr and oil pressure damping force calculate. The concrete contents of Step S500 carry out a back shell detailed explanation based on the sub routine.
[0026] At Step S600, the shift position which can demonstrate the regenerative-braking force to the maximum extent calculates, and transmission 3 is automatically operated towards the aforementioned shift position. The concrete contents of Step S600 carry out a back shell detailed explanation based on the sub routine.
[0027] The ON/OFF bulbs 15f and 15r and the differential pressure bulbs 16f and 16r of drawing 1 are actually controlled by Step S700 that the regenerative-braking force and oil pressure damping force should be distributed by the predetermined ratio. It ** and charge of a battery 1 is presented with the power which the motor 2 generated with regenerative braking of a rear wheel Wr. The concrete contents of Step S700 carry out a back shell detailed explanation based on the sub routine.
[0028] At Step S800, antilock control is performed that a superfluous slip of a front wheel Wf or a rear wheel Wr should be prevented. That is, detection of that the wheel went into the lock state by the output signal of the wheel speed sensor 23 controls the ABS control bulbs 14f and 14r of drawing 1 . The modulator 12 infixed between a master cylinder 9, brake cylinder 13f, and 13r operates by this, the brake oil pressure transmitted to the brake cylinders 13f and 13r of the wheel in the aforementioned lock inclination is decompressed, and the lock of a wheel is prevented.
[0029] At Step S900, a failsafe when failure arises to a regenerative-braking system is planned. That is, as shown in the flow of drawing 3 , when failure arises to a regenerative-braking system, the normally open ON/OFF bulbs 15f and 15r are held in a valve-opening position, and a master cylinder 9 and a modulator 12 are directly open for free passage. Consequently, [the mode 1] is chosen unconditionally and a front wheel Wf and a rear wheel Wr are braked by oil pressure like the usual oil pressure braking system.
[0030] Next, the concrete contents of Step S300 (regenerative-braking force limiting value operation) of the flow chart of above-mentioned drawing 4 are explained based on drawing 5 - drawing 8 .
[0031] Limiting value TLMB of the regenerative-braking force according to the state of a battery 1 at Step S301 first as shown in the regenerative-braking force limiting value operation routine of drawing 5 Limiting value TLMN of the regenerative-braking force calculate and according to the rotational frequency of a motor 2 at Step S302 further It calculates. The aforementioned limiting value TLMB Limiting value TLMN It is compared by Step S303 and size is limiting value TLMB. Limiting value TLMN Limiting value TLMN of the one smaller when large at Step S304 It is chosen as regenerative-braking force limiting value TLM, and is limiting value TLMB. Limiting value TLMN Limiting value TLMB of the one smaller when it is the following at Step S305 It is chosen as regenerative-braking force limiting value TLM. That is, the regenerative-braking force limiting value TLM at that time is the limiting value TLMB by the state of a battery 1. Limiting value TLMN at the rotational frequency of a motor 2 Any or the smaller one is determined.
[0032] Next, the sub routine of Step S301 (limiting value operation by the battery state) of aforementioned drawing 5 is explained based on drawing 6 .
[0033] ** [detection of that brakes operation was performed by the output signal of the brake-pedal treading strength sensor 24 at Step S311 / start / a count / the regeneration on-timer RBT / at Step S312] Then, based on battery remaining capacity a total of 20 output signals, the depth of discharge (DOD) of a battery 1 calculates at Step S313.
[0034] At continuing Step S314 - Step S318, limiting value TLMB0 is determined based on the size of Above DOD. That is, when the value of DOD is small and the remaining capacity of a battery 1 is large, the aforementioned limiting value TLMB0 is set up small, and when the value

of DOD is large and the remaining capacity of a battery 1 is small, the aforementioned limiting value TLMB0 is set up greatly. When it explains in more detail, combining drawing 7 (A) and referring to this, DOD is a threshold D1. It is the following, and when the remaining capacity of a battery 1 is large in comparison, limiting value TLMB0 is set as the comparatively small limiting value TLMB1. Moreover, DOD is a threshold D2. It is above, and when the remaining capacity of a battery 1 is small in comparison, limiting value TLMB0 is set as the large limiting value TLMB3 in comparison. And DOD is the aforementioned threshold D1. Threshold D2 When it is in between, limiting value TLMB0 is set as the limiting value TLMB2 between the above TLMB1 and TLMB3.

[0035] At continuing Step S319, it is based on the output signal of the battery temperature sensor 21, and is the coefficient K1 of an amendment sake about limiting value TLMB0. It is determined. That is, since it increases by the temperature rise, as it is shown in drawing 7 (B), it follows on the output signal TEMP of the battery temperature sensor 21 exceeding TEMP0, and the capacity of a battery 1 is a temperature coefficient K1. It determines to increase from 1 to a linear.

[0036] At continuing Step S320 - Step S324, it is based on the size of the regeneration ON time t which the aforementioned regeneration on-timer RBT counted, and is the coefficient K2 of an amendment sake about limiting value TLMB0. It is determined. The regeneration ON time t which is the elapsed time after regenerative braking is started so that clearly, when drawing 7 (C) is referred to collectively is a threshold t1. When it is the following, it is the charging-time coefficient K2. It is set as 1. The regeneration ON time t is a threshold t1. When it becomes above, it is the aforementioned charging-time coefficient K2. It is set as K22 [smaller than 1], and the regeneration ON time t is a threshold t2 further. When it becomes above, it is the aforementioned charging-time coefficient K2. It is set as K21 [still smaller than the above K22]. Thus, it is the charging-time coefficient K2 in early stages of [when charge of a battery 1 is performed efficiently] charge. It becomes maximum 1, it follows on progress of the regeneration ON time t, and is the aforementioned charging-time coefficient K2. It decreases from 1 to K21 and K22.

[0037] Final regenerative-braking force limiting value TLMB for which it ** and depends on a battery 1 at Step S325 It is a temperature coefficient K1 to the limiting value TLMB0 by DOD. And charging-time coefficient K2 It calculates by carrying out multiplication.

[0038] In addition, the aforementioned regenerative-braking force limiting value TLMB If the treading strength of a line crack and a brake pedal 8 is canceled whenever an operation steps on a brake pedal 8, the aforementioned regeneration on-timer will be reset at Step S326.

[0039] Drawing 8 corresponds to Step S302 of the flow chart of drawing 5 , and is the output signal NM of the motor rotational frequency sensor 22. Limiting value TLMN of the regenerative-braking force to depend Change is shown. It is the rotational frequency NM of a motor 1 so that clearly from this drawing. The limiting value TLMN which increased linearly with the increase becomes abbreviation regularity soon, and decreases rapidly after that.

[0040] Next, the concrete content of Step S500 (regeneration and oil pressure distribution operation) of the flow chart of above-mentioned drawing 4 is explained based on drawing 9 - drawing 17 .

[0041] As shown in drawing 9 , and the regeneration and the oil pressure distribution determination routine of drawing 10 , when braking operation is first performed at Step S501, Mode 1 flag is "0" at Step S502, and [the mode 1] is not chosen. And a regenerative-braking system does not break down at Step S503, and it is not at Step S504 and Step S505 at the slam-on-the-brake time. And a road surface mu is fully large at Step S506 and Step S507, and there is no wheel in a lock inclination. Time differential value deltaVW(s) (depression of per unit time of wheel speed) of the wheel speed calculated from the output signal of the wheel speed sensor 23 as a result are the predetermined threshold g1 and below g2 (g1> g2). And both temporary mode 2 flag M2floor-line' and mode 2 flag M2floor line are "0" at Step S508 and Step S509, and [the mode 2] is not chosen. And at the time of the non-steering by which the steering flag STRFL is not set to "1" at Step S510 and Step S511, [the mode 3] is chosen at Step S512. And when [the mode 1] is chosen at Step S513 when mode 1 flag is set to "1" at the

aforementioned step S502, and mode 2 flag M2floor line is set to "1" at the aforementioned step S509, [the mode 2] is chosen at Step S514.
[0042] Mode 1 flag M1floor line which determines selection in [the mode 1] is set to "1" at Step S515, when which conditions of following ** - ** are satisfied.
** When a regenerative-braking system breaks down at the aforementioned step S503.
** When judged with it being a slam on the brake at the aforementioned step S504 and Step S505.
** It is time differential value deltaVW of wheel speed at the aforementioned step S506. Threshold g1 of the larger one When it exceeds. (It is chosen as a value presumed that g1 becomes a lock also with the braking force distribution of the usual oil pressure damping device closely)
** It is time differential value deltaVW of wheel speed at the aforementioned step S507. Threshold g1 of the larger one Threshold g2 of the smaller one When it is the case (g2 will be chosen as a value presumed that a lock is canceled if it returns to the braking force distribution of the usual oil pressure damping device) where it is in between and M2floor line is set to "1" for mode 2 flag at Step S516.
[0043] Moreover, temporary mode 2 flag M2floor-line' which determines selection in [the mode 2] is set to "1" at Step S522, when the conditions of following ** are satisfied, and when the same conditions of ** of the following [floor line / mode 2 flag M2] or ** are satisfied, it is set to "1" at Step S517.
** It is time differential value deltaVW of wheel speed at the aforementioned step S507. Threshold g2 of the smaller one When it has exceeded, M2floor line is not set to "1" for mode 2 flag at Step S516 (namely, state where [the mode 3] is chosen) but M2 delay timer M2T are moreover counting down at Step S518 and Step S519.
** In the aforementioned steps S518 and S519, while M2 delay timer M2T count down (namely, M2floor-line'=1), it is time differential value deltaVW of wheel speed at Step S507. Threshold g2 of the smaller one When it becomes below, or when the predetermined time by M2 delay timer M2T passes. In addition, it also sets after progress of the predetermined time by M2 delay timer M2T, and is deltaVW >g2 at Step S507. [The mode 1] will be chosen by the conditions of the aforementioned ** if judged.
** When judged with it being among a steering at the aforementioned step S510 and Step S511.
[0044] When it is judged at the aforementioned step S501 that it is not during brakes operation (i.e., when the treading strength of a brake pedal 8 is canceled), both mode 2 flag M2floor line and mode 1 flag M1floor line are set to "0" at Step S523 and Step S524 for the first time. Therefore, once [the mode 2] or [the mode 1] is chosen during one braking, it will not reverse-shift to [the mode 3] from [the mode 2] or [the mode 1] during the braking.
[0045] Next, the detail of Step S504 (slam-on-the-brake judging) of drawing 9 is explained with reference to the flow chart of drawing 11 . Treading strength FB detected by the brake-pedal treading strength sensor 24 in Step S531 When it is more than a predetermined threshold, it is judged with it being a slam on the brake unconditionally, and a slam-on-the-brake flag is set to "1" at Step S532.
[0046] On the other hand, it is the aforementioned treading strength FB. It is under a predetermined threshold and the slam-on-the-brake judging timer PTM is the initial value t0 at the time of a count start at Step S533. When it is, it is the treading strength FB at that time at Step S534. It considers as the initial treading strength FB1. When the slam-on-the-brake judging timer PTM is not counting down to 0 at continuing Step S535, while a count-down is performed at Step S536, a slam-on-the-brake flag is set to "0" at Step S537.
[0047] Predetermined time t0 when the slam-on-the-brake judging timer PTM counts down to 0 at the aforementioned step S535 When it passes, it is the treading strength FB at that time at Step S538. t0 It considers as the next treading strength tB2, and the slam-on-the-brake judging timer PTM is t0 at Step S539. It is reset. And it is t0 at continuing Step S540. Next treading strength tB2 The difference of the initial treading strength FB1 is treading strength change threshold deltaFB. It is compared and the aforementioned difference is treading strength change threshold deltaFB. If it has exceeded, and a slam-on-the-brake flag is set to "1" and has not

exceeded at Step S532, a slam-on-the-brake flag is set to "0" at Step S537.
[0048] Thus, treading strength FB Treading strength FB in a predetermined time when it exceeds the 1st threshold When an augend exceeds the 2nd threshold, it is judged with it being a slam on the brake.
[0049] Next, the detail of Step S510 (steer condition judging) of drawing 10 is explained with reference to the flow chart of drawing 12 , and the graph of drawing 13 . The vehicle speed V calculated from the output signal of the wheel speed sensor 23 is the largest threshold V3. When large The rudder angle theta detected by the steering sensor 26 is the smallest threshold theta 1. When large, the steering flag STRFL is set to "1." The aforementioned threshold theta 1 The steering flag STRFL is set to "0" at the following times (Steps S541, S542, S543, S544, and S545, S546 reference).
[0050] the vehicle speed V -- largest threshold V3 Threshold V2 smaller than it the time of being in between -- a rudder angle theta -- middle threshold theta 2 when large, the steering flag STRFL sets to "1" -- having -- a rudder angle theta -- threshold theta 2 When it is the following, the steering flag STRFL is set to "0" (Steps S541, S542, S543, S547, and SS545, S546 reference).
[0051] the vehicle speed V -- the aforementioned threshold V2 Smallest threshold V1 the time of being in between -- a rudder angle theta -- largest threshold theta 3 when large, the steering flag STRFL sets to "1" -- having -- a rudder angle theta -- threshold theta 3 When it is the following, the steering flag STRFL is set to "0" (Steps S541, S542, S548, and S545, S546 reference).
[0052] The vehicle speed V is the smallest threshold V1. When it is the following, it is not concerned with the size of a rudder angle theta, but the steering flag STRFL is set to "0" (Steps S541 and S546).
[0053] Thus, when high, even if the vehicle speed V is the small rudder angle theta, judgment that it is among a steering is made, and if the vehicle speed V is not the large rudder angle theta at the time of a low, a judgment will not be given to be among a steering.
[0054] Next, the detail of Step S512 (mode 3 distribution determination) of drawing 10 is explained with reference to the flow chart of drawing 14 , and the graph of drawing 17. By carrying out the multiplication of the gear ratio [of n **] R (n) to the regenerative-braking force limiting value TLM calculated at Step S300 of aforementioned drawing 4 in Step S551, the conversion regenerative-braking force limiting value TRGLM converted into tire torque calculates. Based on the graph of drawing 17 (A), the treading strength FB0 corresponding to the break point P in the braking-force-distribution property of aforementioned drawing 1 (point that oil pressure braking of a front wheel Wf is started in [the mode 3]) is searched with continuing Step S552.
[0055] At Step S553, it is based on the graph of drawing 17 (B), and is treading strength FB. The conversion regenerative-braking force TRG of corresponding is searched. At continuing Step S554, the amount of Fr offset, i.e., a linear solenoid 19f [of drawing 1] control input, calculates by carrying out the multiplication of the constant to the aforementioned break-point treading strength FB0. Based on the graph of drawing 17 (C), the amount of Rr offset, i.e., the control input of linear solenoid 19r of drawing 1 , is searched with Step S555. It ** and both Fr offset flags and Rr offset flags that control the ON/OFF bulbs 15f and 15r of drawing 1 by Step S556 are set to "1" (valve closing).
[0056] Next, the detail of Step S514 (mode 2 distribution determination) of drawing 10 is explained with reference to the flow chart of drawing 15 , and the graph of drawing 17 . The conversion regenerative-braking force limiting value TRGLM converted into tire torque calculates by carrying out the multiplication of the gear ratio [of n **] R (n) to the regenerative-braking force limiting value TLM calculated at Step S300 of aforementioned drawing 4 in Step S561. The conversion regenerative-braking force TRG is searched with continuing Step S562 based on the graph of drawing 17 (D).
[0057] At Step S563, the amount of Fr offset is set as 0. This is because the braking-force-distribution property in in the [mode 2] of drawing 1 does not have the aforementioned break point P but oil pressure braking of a front wheel Wf is performed from the time of initial braking.

Based on the graph of drawing 17 (C), the amount of Rr offset, i.e., the control input of linear solenoid 19r of drawing 1 , is searched with continuing Step S564. It **, Fr offset flag which controls ON/OFF bulb 15f by the side of the front wheel of drawing 1 by Step S565 is set to "0" (valve opening), and Fr offset flag which makes ON/OFF bulb 15r by the side of a rear wheel close is set to "1" (valve closing).
[0058] Next, the detail of Step S513 (mode 1 distribution determination) of drawing 10 is explained with reference to the flow chart of drawing 16 . In this the [mode 1], since regenerative braking is not performed, in Step S571, the conversion regenerative-braking force TRG is set as 0. At both the continuing steps S572 and S573, the amount of Fr offset and the amount of Rr offset are set as 0. And finally both Fr offset flag and Fr offset flag are set to "0" (valve opening) at Step S574, the oil pressure which a master cylinder 9 generates is transmitted to a modulator 12 as it is, and a front wheel Wf and a rear wheel Wr are braked by the usual oil pressure.
[0059] Next, the detail of Step S600 (shift instructions) of drawing 4 is explained based on the flow chart of drawing 18 - drawing 20 , the graph of drawing 21 , and the timing diagram of drawing 22 .
[0060] When it is under shift in Step S601 of the flow chart of drawing 18 - drawing 20 , while the shift flag SHFL is set to "1" and the conversion regenerative-braking force TRG is continuously set as 0 at Step S603 by Step S602, both Fr offset flag and Rr offset flag are set to "0" (valve opening) at Step S604. Thereby, during a shift, a front wheel Wf and a rear wheel Wr are braked by the usual oil pressure, without performing regenerative braking.
[0061] In spite of not being [be / it] under shift at Step S601, when the shift flag SHFL is set to "1" at Step S605, it is judged that the shift was completed, and while oil pressure braking of a front wheel Wf and a rear wheel Wr is canceled at continuing Step S606, the shift flag SHFL is set to "0" at Step S607.
[0062] Moreover, it is among a steering at Step S608, and when the steering flag STRFL is set to "1", the below-mentioned shift instructions are not performed.
[0063] Regeneration energy E in the shift-position n present at continuing Steps S609-S613 (n) It calculates. That is, it is gear ratio R (n) about the conversion regenerative-braking force TRG at Step S609. Motor torque [in / n ** / by carrying out a division] TMT (n) It calculates. and the step S612 -- the graph of drawing 21 -- being based -- the aforementioned motor torque TMT (n) Rotational frequency NM of a motor 2 from -- Step S613 which motor-efficiency eta (n) is called for and continues -- aforementioned motor-efficiency eta (n) Motor torque TMT (n) Rotational frequency NM of a motor 2 Regeneration energy E [in / the shift-position n concerned / by carrying out multiplication] (n) It calculates.
[0064] Next, regeneration energy E at the time of carrying out a down shift from the present shift position in Steps S614-S622 (n-1) It calculates. Namely, regeneration energy E at the time of carrying out a down shift at Step S615, since the down shift is substantially impossible when the shift-position n present at Step S614 is the 1st speed (n-1) It is set as 0. Regeneration energy E at the time of on the other hand, carrying out a down shift to n-1st speed like the above-mentioned at Steps S616-S622, when the shift-position n present at the aforementioned step S614 is in any of the 2nd speed - the 4th speed (n-1) It calculates. In that case, it is the motor torque TMT (n-1) at Step S617. When it exceeds the regenerative-braking force limiting value TLM, the aforementioned regenerative-braking force limiting value TLM is the motor torque TMT (n-1) at Step S618. It is carried out. moreover -- the case of a down shift -- Step S619 -- rotational frequency NM (n-1) of the motor 2 at the time of a down shift gear ratio R (n) R (n-1) Rotational frequency NM in n ** (n) from -- it calculates -- having -- the result -- Step S620 -- rotational frequency NM (n-1) the case where it becomes OBAREBU -- the aforementioned step S615 -- regeneration energy E (n-1) It is set as 0.
[0065] Next, regeneration energy E at the time of carrying out a shift up from the present shift position in Steps S623-S630 (n+1) It calculates. Namely, regeneration energy E at the time of carrying out a shift up at Step S624, since the shift up is substantially impossible when the shift-position n present at Step S623 is the 4th speed (n+1) It is set as 0. Regeneration energy E at the time of carrying out a shift up like the above-mentioned at continuing Steps S625-S630

(n+1) It calculates. In that case, it is the motor torque TMT (n+1) at Step S626. When it exceeds the regenerative-braking force limiting value TLM, the aforementioned regenerative-braking force limiting value TLM is the motor torque TMT (n+1) at Step S627. It is carried out. In addition, since OBAREBU does not occur in the case of the aforementioned shift up, the judgment of OBAREBU performed when it was a down shift is not performed.
[0066] **(ing) -- present at Steps S631-S633 regeneration energy E (n) The regeneration energy E at the time of carrying out a down shift (n-1), and regeneration energy E at the time of carrying out a shift up (n+1) Three persons are compared. E (n-1) When becoming the maximum, down-shift instructions are emitted at Step S634, and it is E (n+1) conversely. When becoming the maximum, shift up instructions are emitted at Step S635.
[0067] Above-mentioned shift operation is explained based on the timing diagram of drawing 22 . For example, the treading strength of a brake pedal 8 is time T1, T3, and T8. It is operated so that it may set and may become strong gradually, and it is time T2. Suppose that regenerative-braking instructions were emitted. When it is judged that the down shift of the shift position is carried out to the 2nd speed from the 3rd speed that regeneration energy should be made the maximum at this time, it is time T4. It sets and a clutch is canceled.
[0068] since a rear wheel Wr and a motor 2 will be separated and the regenerative-braking force will become impossible, if a clutch is canceled -- time T4 from -- T7 up to -- regenerative-braking instructions of a motor 2 are canceled and while regenerative braking is not performed time T4 from -- T7 up to -- in between, hydraulic brake instructions are issued and oil pressure braking substitutes regenerative braking **(ing) -- time T4 from -- T6 up to -- time T5 in the engagement release period of a clutch It sets, shift instructions are emitted and the down shift from the 3rd speed to the 2nd speed is performed.
[0069] above -- carrying out -- total damping force -- time T2 -T4 **** -- regenerative braking -- time T4 -T7 **** -- oil pressure braking -- time T7 -T9 **** -- regenerative braking -- time T9 It is secured by combined use of regenerative braking and oil pressure braking henceforth.
[0070] Next, the detail of Step S700 (regeneration and oil pressure braking force control) of drawing 4 is explained based on the flow chart of drawing 23 .
[0071] First, the conversion regenerative-braking force TRG is outputted at Step S701. And in [the mode 3] and [the mode 2], regenerative braking of the rear wheel Wr is carried out so that the aforementioned conversion regenerative-braking force TRG may be acquired at the time of initial braking, and charge of a battery 1 is presented with the power which the motor 2 generated with this regenerative braking so that clearly from drawing 1 . At Steps S702 and S703, Steps S554 and S555 of drawing 14 corresponding to [the mode 3], Steps S563 and S564 of drawing 15 corresponding to [the mode 2], and the amount of Fr offset and the amount of Rr offset determined in Steps S572 and S573 of drawing 17 corresponding to [the mode 1] are outputted. Consequently, the linear solenoids 19f and 19r of the oil-pressure-control bulb of the front wheel Wf shown in drawing 1 and a rear wheel Wr operate, and the set load of the springs 17f and 17r of the differential pressure bulbs 16f and 16r is adjusted to a predetermined size.
[0072] If Fr offset flag is not set to "1" at continuing Step S704 (in the case of [the mode 2] and [the mode 1]), and it is maintained at a valve-opening state ON/OFF bulb 15f of drawing 1 at Step S705 and is conversely set to "1" (in the case of [the mode 3]), valve-closing operation will be carried out ON/OFF bulb 15f at Step S706.
[0073] Therefore, in [the mode 2] and [the mode 1] in which ON/OFF bulb 15f is maintained at a valve-opening state, the brake oil pressure which the master cylinder 9 generated is transmitted to the direct modulator 12, and as shown in the braking-force-distribution property in in the [mode 2] of drawing 1 , and the [the mode 1], oil pressure braking of the front wheel Wf is carried out from the time of initial braking.
[0074] On the other hand, in [the mode 3], since valve-closing operation of the ON/OFF bulb 15f is carried out, although the brake oil pressure which the master cylinder 9 generated is prevented by the aforementioned ON/OFF bulb 15f and it is transmitted to a modulator 12 via differential pressure bulb 16f, it does not open differential pressure bulb 16f until the treading strength of a brake pedal 8 increases in a predetermined value according to a spring 17f set load

in that case. Consequently, as shown in the segment OP in the braking-force-distribution property in in the [mode 3] of drawing 1 , it is prevented that oil pressure damping force acts on a front wheel Wf at the time of initial braking. And when the brake oil pressure which the master cylinder 9 generated becomes a size corresponding to the aforementioned break point P, differential pressure bulb 16f will open and oil pressure damping force will begin to act on a front wheel Wf.
[0075] If it returns to the flow chart of drawing 23 , and Rr offset flag is not set to "1" at Step S707 (in the case of [the mode 1]), and ON/OFF bulb 15r is maintained at a valve-opening state at Step S708 and it is conversely set to "1" (in the case of [the mode 3] and [the mode 2]), valve-closing operation of the ON/OFF bulb 15r will be carried out at Step S709.
[0076] Therefore, in the [mode 1] in which ON/OFF bulb 15r is maintained at a valve-opening state, the brake oil pressure which the master cylinder 9 generated will be transmitted to the direct modulator 12, and as shown in the braking-force-distribution property in in the [mode 1] of drawing 1 , oil pressure braking of the rear wheel Wr is carried out from the time of initial braking.
[0077] On the other hand, in [the mode 3] and [the mode 2], differential pressure bulb 16r does not open until the brake oil pressure which the master cylinder 9 generated will be prevented by the aforementioned ON/OFF bulb 15r, it will be transmitted to a modulator 12 via differential pressure bulb 16r and the treading strength of a brake pedal 8 increases in a predetermined value according to the set load of spring 17r, since valve-closing operation of the ON/OFF bulb 15r is carried out. Consequently, it is prevented that oil pressure damping force acts on a rear wheel Wr to the regeneration limitation in the braking-force-distribution property in in the [mode 3] of drawing 1 and the [the mode 2]. And when the brake oil pressure which the master cylinder 9 generated becomes a size corresponding to the aforementioned regeneration limitation, differential pressure bulb 16r will open, oil pressure damping force will begin to act on a rear wheel Wr, and the regenerative-braking force and oil pressure damping force will act on a rear wheel Wr after it.
[0078] Drawing 24 shows another example which simplified the regeneration and the oil pressure distribution determination routine shown in drawing 9 and drawing 10 .
[0079] this example -- a regenerative-braking system -- not breaking down -- and the inside of a steering -- not but -- and treading strength -- more than a threshold -- not but -- and when not low, the usual [mode 3] is chosen for a road surface mu (Steps S581, S582, S583, S584, S585, and S586, S587 reference)
[0080] When the regenerative-braking system is out of order at the aforementioned step S581, in Step S589, [the mode 1] is chosen unconditionally. Moreover, when it is judged that treading strength becomes more than a threshold and it is a slam on the brake at Step S584 when it is judged at Steps S582 and S583 that it is among a steering, or when it is judged that a road surface mu is low at Steps S585 and S586, and there is possibility of a wheel lock, [the mode 2] is chosen at Step S588.
[0081] Drawing 25 shows the sub routine of Step S582 (steer condition judging) of aforementioned drawing 24 , it is judged that it is among a stay ring when the lateral acceleration of vehicles is beyond a reference value in Step S591, the steering flag STRFL is set to "1" at Step S592, it is judged that it is not among a stay ring when it is under a reference value, and the steering flag STRFL is set to "0" at Step S593. In addition, it is also possible to replace with the lateral acceleration of vehicles at the aforementioned step S591, and to judge steer conditions by making the yaw rate r of vehicles into a parameter.
[0082] As mentioned above, although the example of this invention was explained in full detail, it is not limited to the aforementioned example and this invention can perform various small design changes.
[0083] For example, in the example, although the vehicles whose rear wheel Wr a front wheel Wf is a coupled driving wheel, and is a driving wheel were illustrated, this invention is applicable also to the vehicles whose rear wheel Wr a front wheel Wf is a driving wheel and is a coupled driving wheel.
[0084]

[Effect of the Invention] All the kinetic energy can be used for regenerative braking of a driving wheel, without consuming the kinetic energy of vehicles by oil pressure braking of a coupled driving wheel according to the 1st feature of this invention, as mentioned above, since oil pressure braking of a coupled driving wheel was regulated by the aforementioned differential pressure bulb when a differential pressure bulb was made to intervene between a master cylinder and the brake cylinder of a coupled driving wheel and regenerative braking of a driving wheel was performed. Thereby, energy by regenerative braking is collected effectively and it becomes possible to make rolling-stock-run possible distance increase.
[0085] Moreover, all the kinetic energy can be used for regenerative braking of a driving wheel, without consuming the kinetic energy of vehicles by oil pressure braking of a driving wheel, since according to the 2nd feature of this invention oil pressure braking of a driving wheel was regulated by the aforementioned differential pressure bulb when a differential pressure bulb was made to intervene between a master cylinder and the brake cylinder of a driving wheel and regenerative braking of a driving wheel was performed. Thereby, energy by regenerative braking is collected effectively and it becomes possible to make rolling-stock-run possible distance increase.
[0086] Moreover, since the set load of the spring which determines the size of the braking oil pressure of which regulation of oil pressure braking of a coupled driving wheel or a driving wheel is canceled can be adjusted according to the 3rd feature of this invention, distribution of the regenerative-braking force and oil pressure damping force can be set up easily.
[0087] Moreover, since the ON/OFF bulb which closes at the time of regenerative braking and is opened at the time of oil pressure braking was made to intervene between the brake cylinders of a master cylinder, a coupled driving wheel, or a driving wheel according to the 4th feature of this invention, when regenerative braking becomes impossible, it becomes possible to open the aforementioned ON/OFF bulb and to carry out oil pressure braking of a coupled driving wheel or the driving wheel.

[Translation done.]